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GRID BASED EVOLUTIONARY OPTIMIZATION OF STRENGTH PARAMETERS IN HEAT AFFECTED ZONE OF WELDED JOINTS

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ABSTRACT

A grid based evolutionary optimization [3] of welding parameters influences on strength parameters in the heat affected zone (HAZ) is shown in the paper. Numerical simulation of a welding process using the finite element method is applied [1,2]. Results for coupled thermo-mechanical problem are prescribed. The objective of the welding simulation is to study the temperature generated during the welding process and investigate residual stresses in the component after welding. Such results give the possibility to determine properties of materials in welding zones, stress and strain state of welded parts. From the other hand it allows to perform optimization process determining welding parameters (welding speed, welding power source, cooling temperature etc.) affected on the strength parameters of the material in HAZ. The initial shape of welded sheets according to displacement state, folding problem with welding of thin metal sheets with stiffeners – T joints, can also be optimized. Welding is one of the most commonly used join process but till now it is still difficult to simulate numerically in common CAE systems based on finite element method. In most of CAE systems it is required to write specialized user subroutines for specific boundary conditions (a heat source, a weld path, a filler element treatment, a material behaviour etc.). It makes it difficult and inconvenient in practical use. Welding simulation gives a lot of information very important for engineers. An undesirable side-effect of welding is the generation of residual stresses and deformations in the component and the quality of the weld has a substantial impact on the fatigue life of the structure. Considered simulation allows to determine the cooling period from 800°C to 500°C (so-called cool-down rate t8/5), which is used to model the strength parameters in a heat-affected zone. Finding the optimal value of t8/5 is one of the primary goal of simulation and optimization of the welding process.

The obtained results from welding simulation are the base for optimization process of welding parameters for obtaining the required strength parameters in welded parts. The simulation is time consuming and an optimization using the standard procedures is not possible. A parallel or distributed calculations can give expected results in

acceptable time. As the evolutionary algorithms cooperate very good with this techniques and allow to freely define the fitness function based on the complicated parameters they are chosen as the optimization method here.

In the paper the application of grid based evolutionary optimization is presented. The welding parameters (velocity, source power, cooling temperature and time, shape of the source, heat input, weld flux etc.) are determined by chromosomes genes. The fitness function depends on a cooling time in selected point of HAZ for process parameters described by chromosome.

The following example, a solid flange to a pipe connection, (Fig. 1) shows results for the complex welding process simulation and modelling of strength parameters in HAZ.

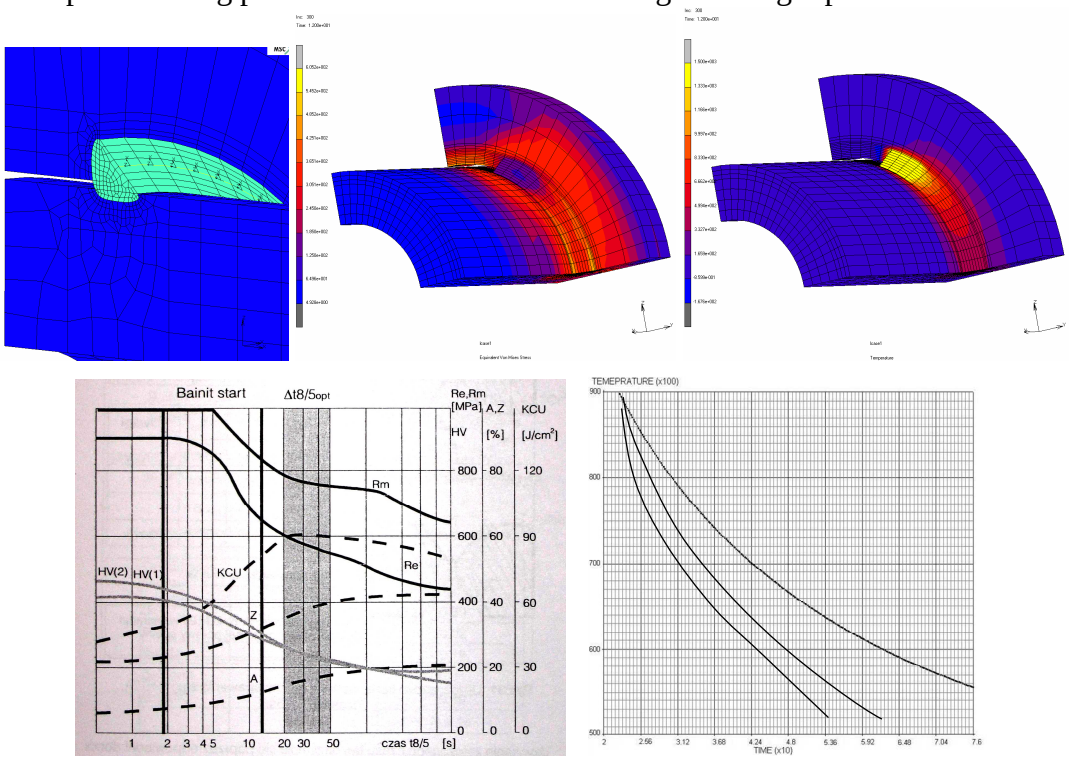

Fig. 1 The complex set of results of the welding process simulation: a. the model, b. von Mises stresses during welding, c. temperature distribution, d. cooldown rate t8/5 in the HAZ – the reference diagram and calculated one.

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